



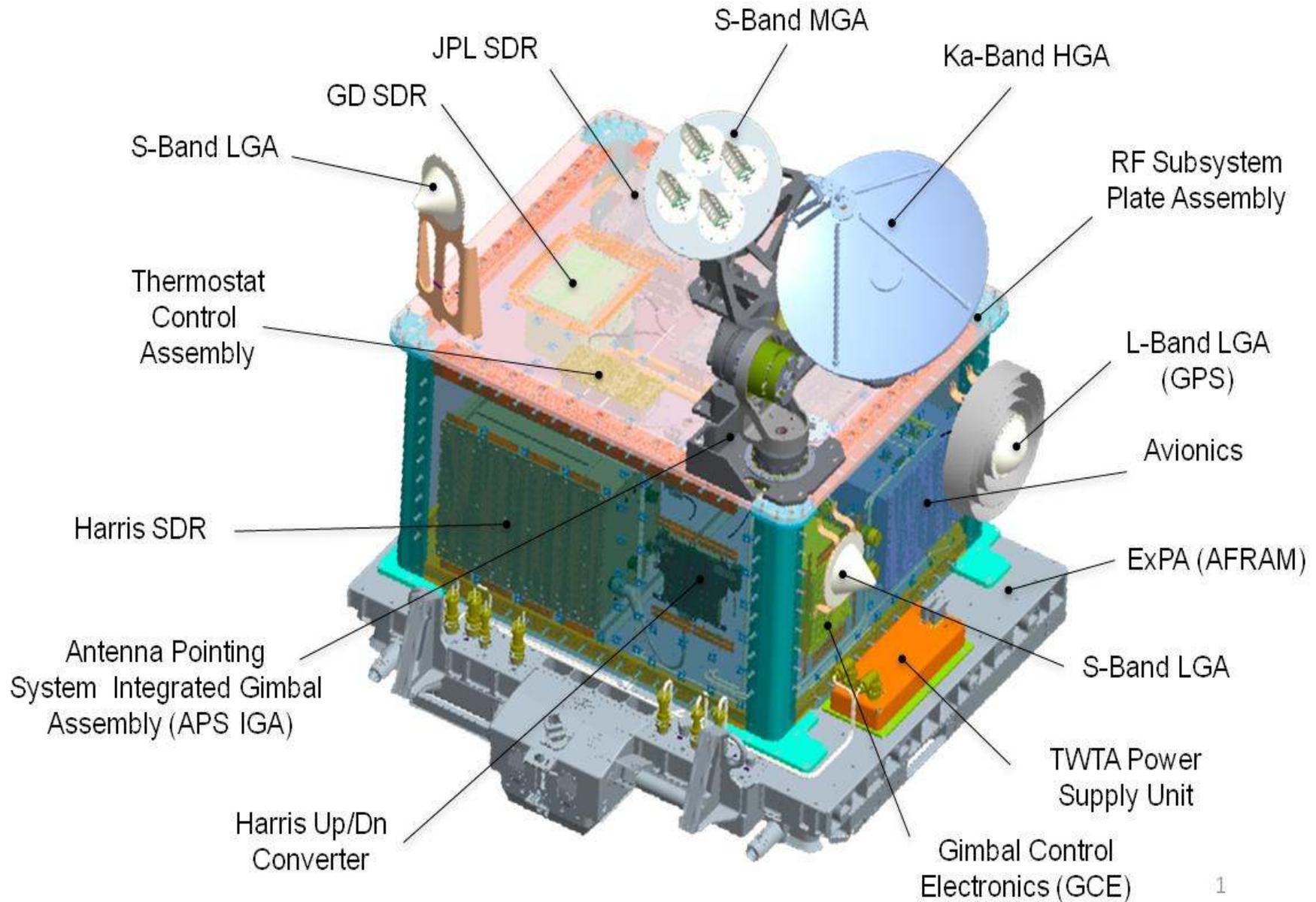
Space Software Defined Radio Characterization to Enable Reuse

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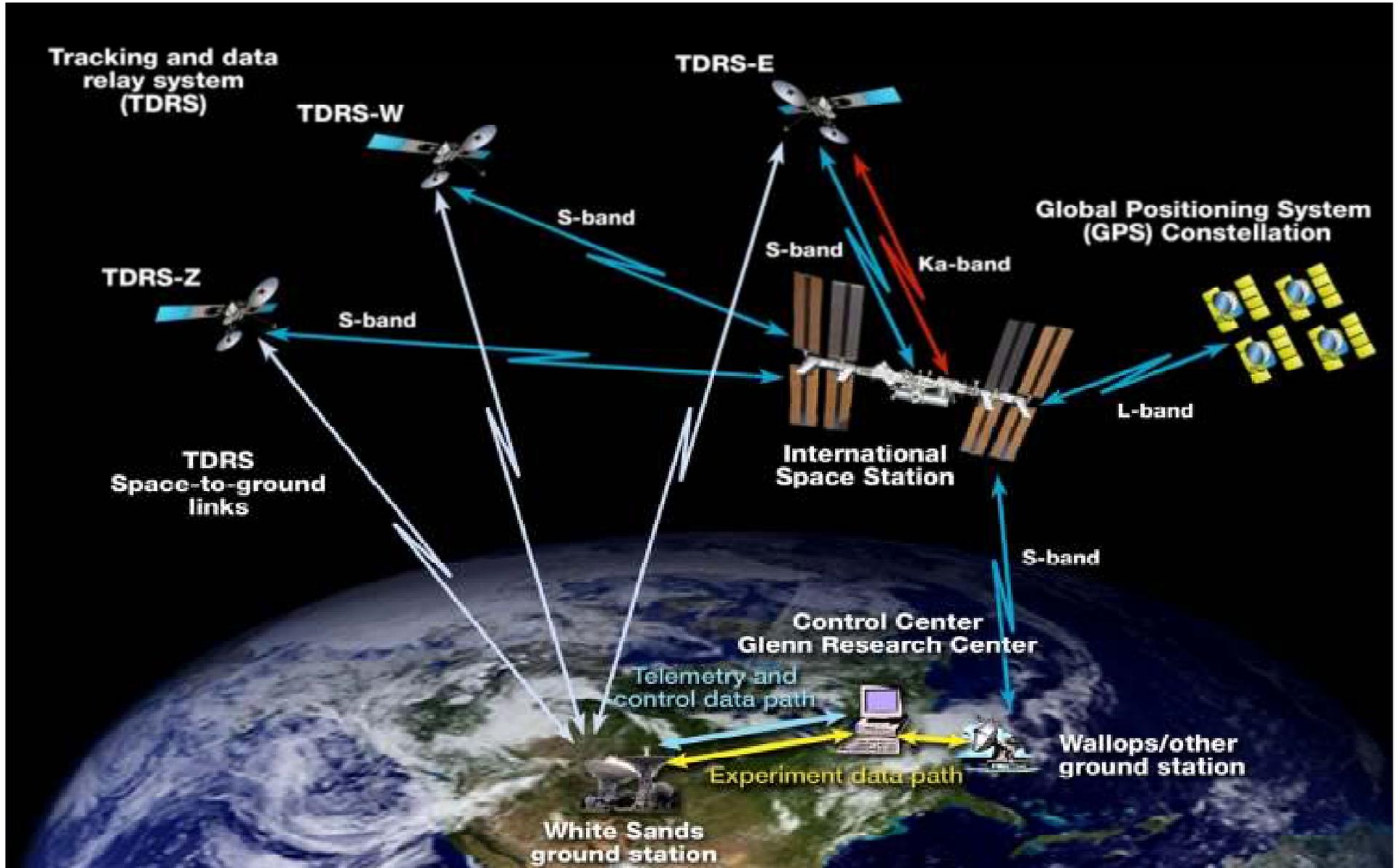


Space Communications and Navigation (SCaN) Testbed



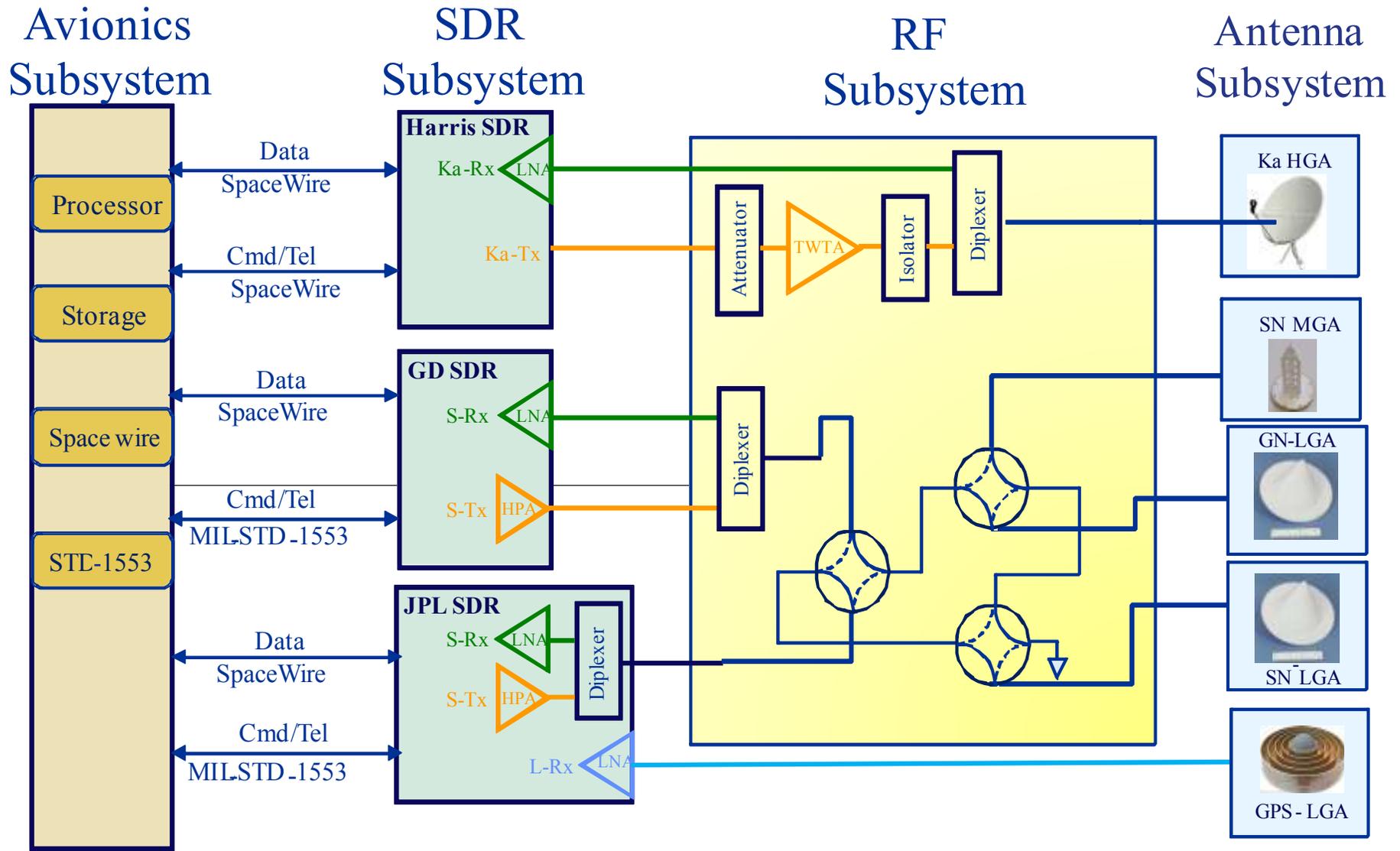


SCaN Testbed Architecture





SCaN Testbed - subsystems





Baseline Operational Waveforms



SDR	TDRSS Mode	Modulation	Tx Data Rate* (kbps)	Rx Data Rate* (kbps)
GD	S-band DG1, Mode 1	SQPN I/Q Power Ratio – 1:1	192	72
GD	S-band DG1, Mode 3	QPSK I/Q power ratio – 1:4	Q:1000 I: 1	72
GD	S-band DG2	SQPSK I/Q power ratio 1:1	1000	72
JPL	S-band DG1, Mode 2	SS-BPSK	24	18
JPL	S-band DG2	BPSK	769	769
Harris	Ka-band DG2	SQPSK I/Q power ratio 1:1	100000	12500

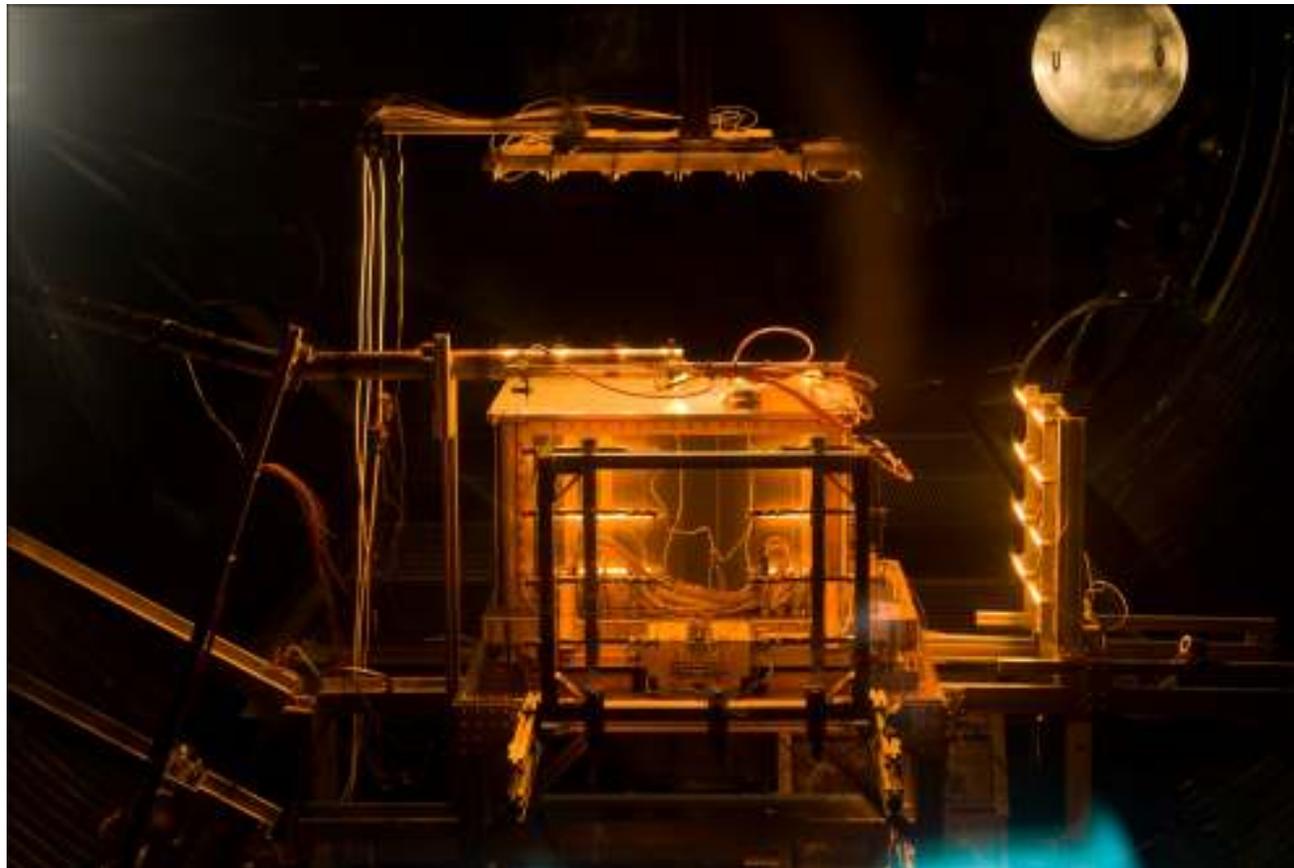
** Only data rates tested. SDRs capable of variable data rates.*



Characterizing the SDRs



- ◆ Done in controlled environment before launch: thermal vacuum testing, EMI testing
- ◆ Each SDR has hardware compensations performed by software as part of design



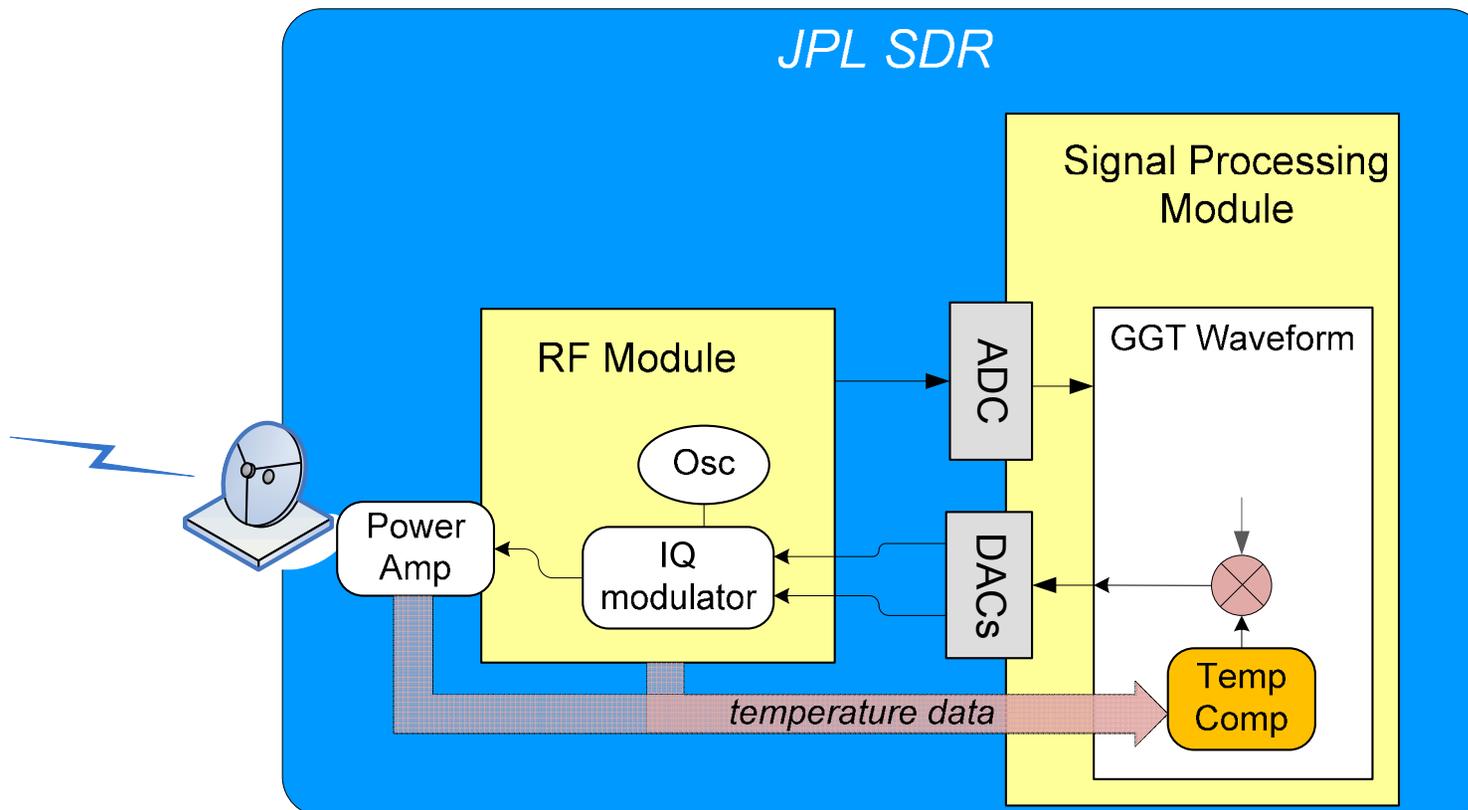


Temperature Compensation



Adjusts for:

- ◆ ***IQ modulator imbalance***
- ◆ ***output power level***
- ◆ ***carrier frequency offset***



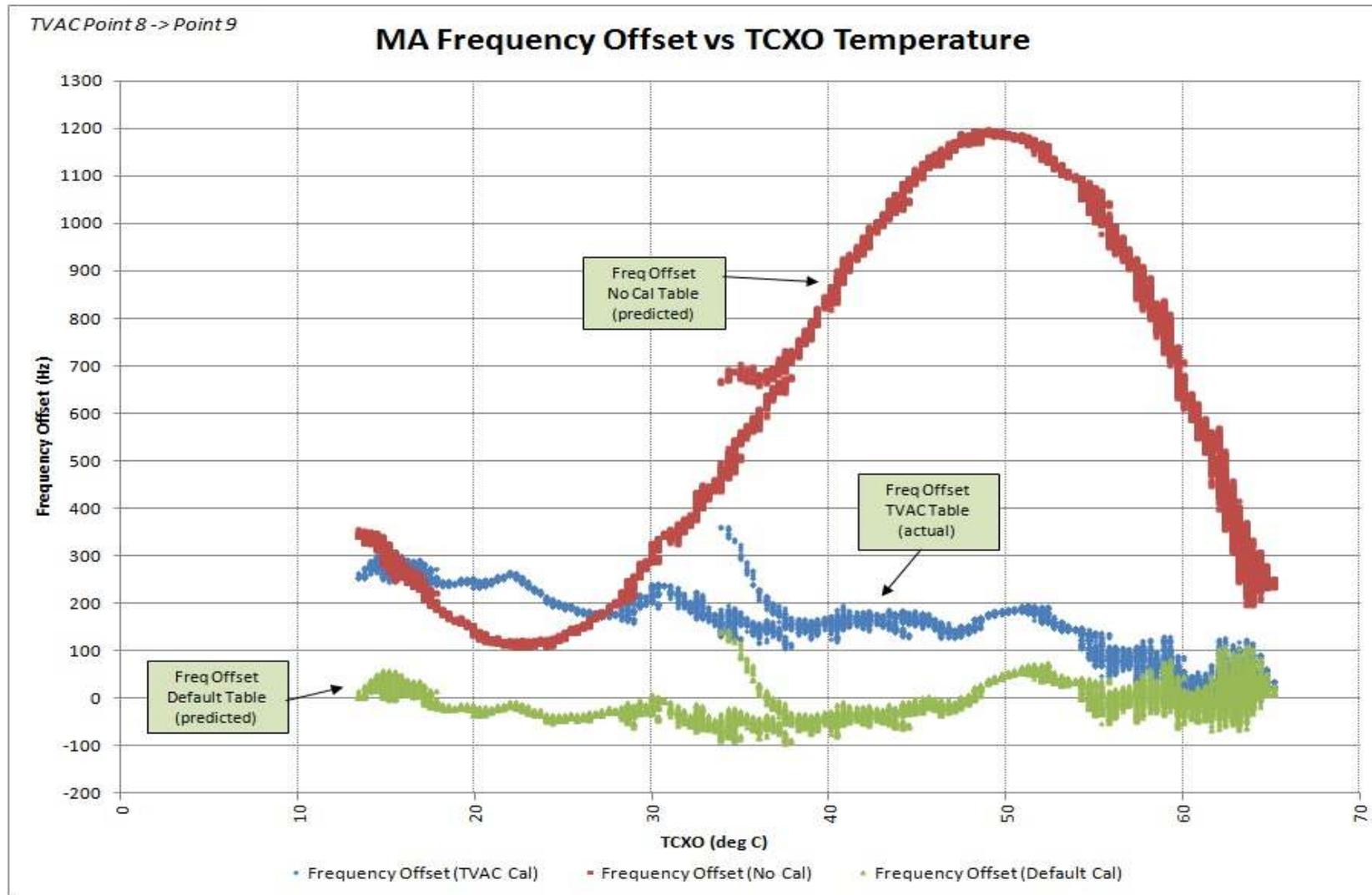
Compensation is re-configurable on-orbit.



Temperature Compensation - frequency



Baseband I & Q data frequency shifted to trim transmitter output over temp.



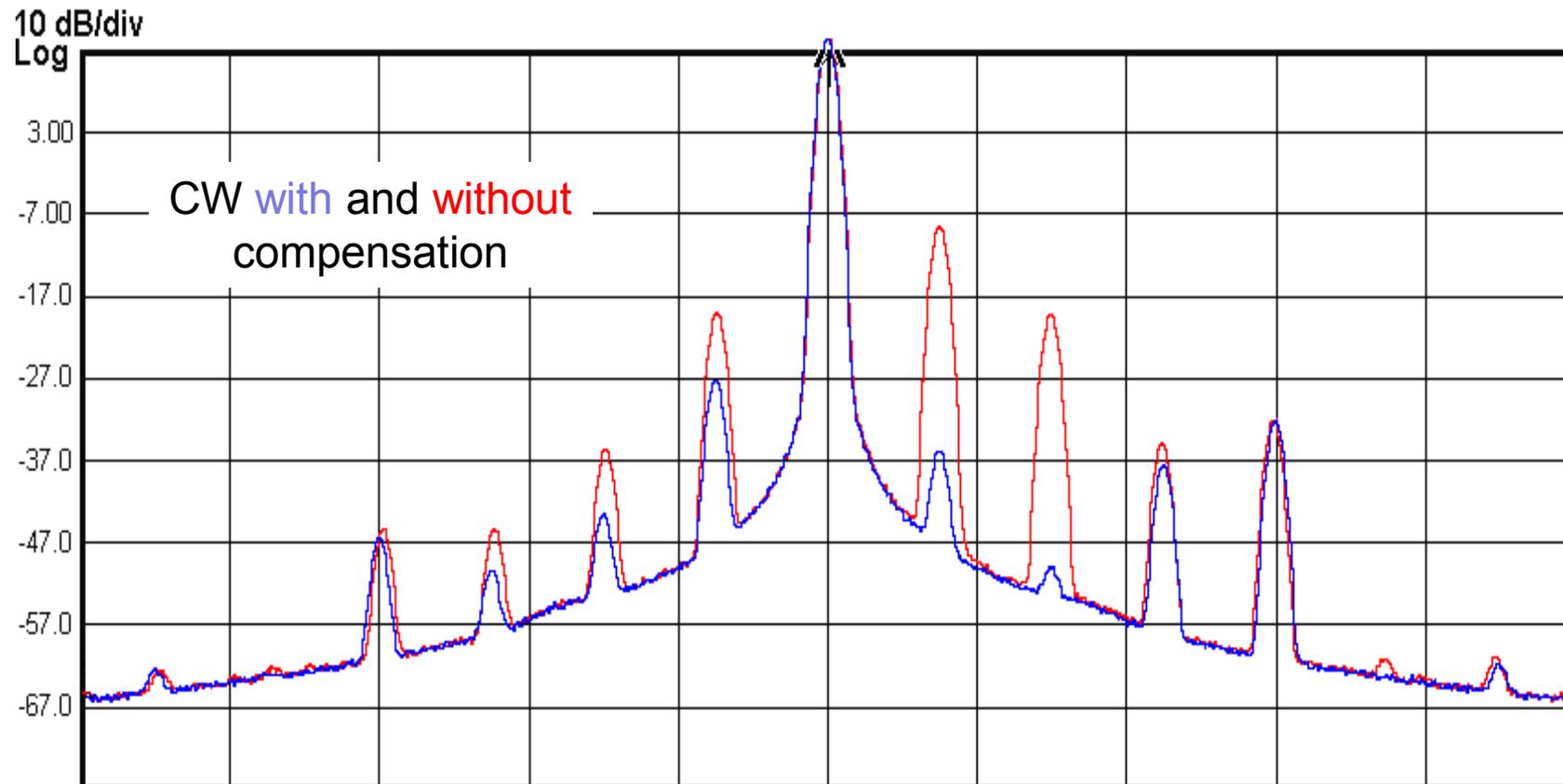


Temperature Compensation - modulator



Digital baseband pre-compensation of analog modulator

- ◆ DC offsets
- ◆ DC levels
- ◆ Phase offset

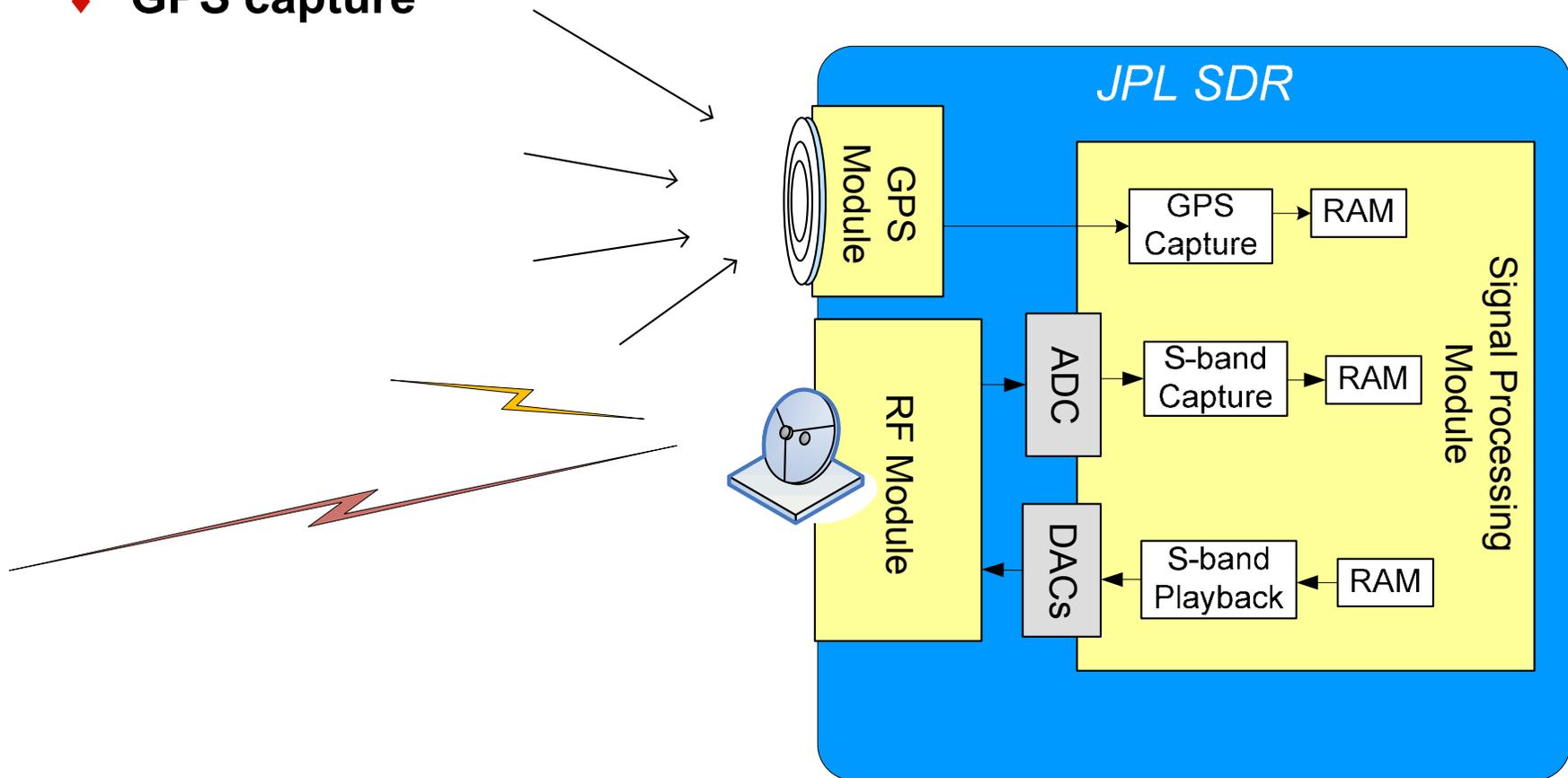




Baseline JPL SDR Test Waveforms

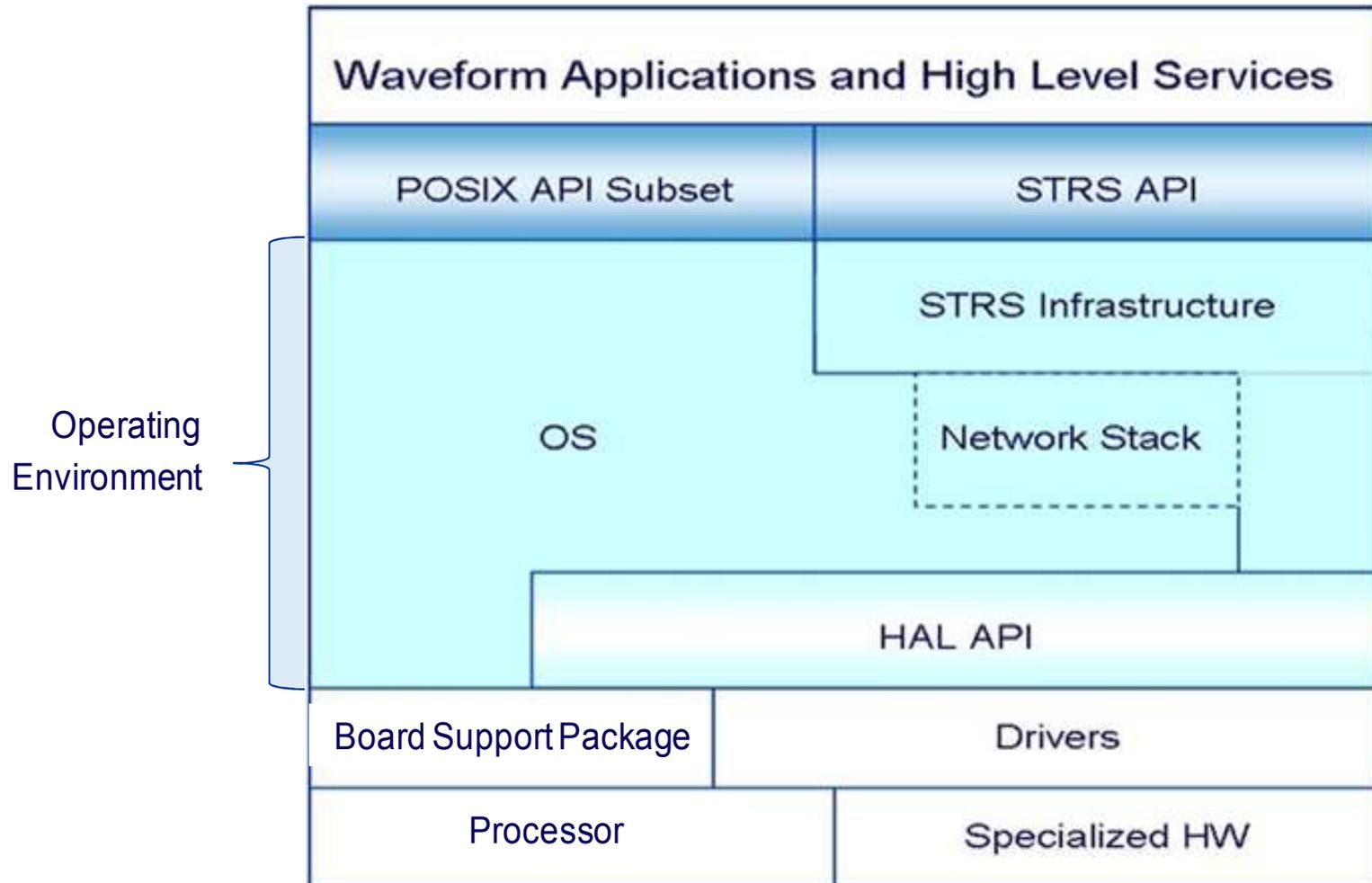


- ◆ S-band capture
- ◆ S-band playback
- ◆ GPS capture





Space Telecommunications Radio System





STRS Waveform Ground Test



- ◆ **As defined by STRS, a ground test is a waveform function intended for development, integration, or environmental testing purposes usually conducted on the ground before deployment.**
- ◆ **The code does not go into the flight build.**
- ◆ **The GGT Waveform had the following ground tests that were used for radio characterization and calibration:**
 - I DC offset sweep
 - Q DC offset sweep
 - Q level sweep
 - I level sweep
 - Q phase sweep
 - I & Q level sweep
 - Sweep Table dump

```
jplggt: Starting DC Offset sweep on Q
jplggt: Average RFM Temperature=1296.7, TCXO=1478.0
jplggt: Setting DC Offset to Q DC -0.080000
jplggt: Setting DC Offset to Q DC -0.066667
jplggt: Setting DC Offset to Q DC -0.053333
jplggt: Setting DC Offset to Q DC -0.040000
jplggt: Setting DC Offset to Q DC -0.026667
jplggt: Setting DC Offset to Q DC -0.013333
```



STRS Waveform Run Tests



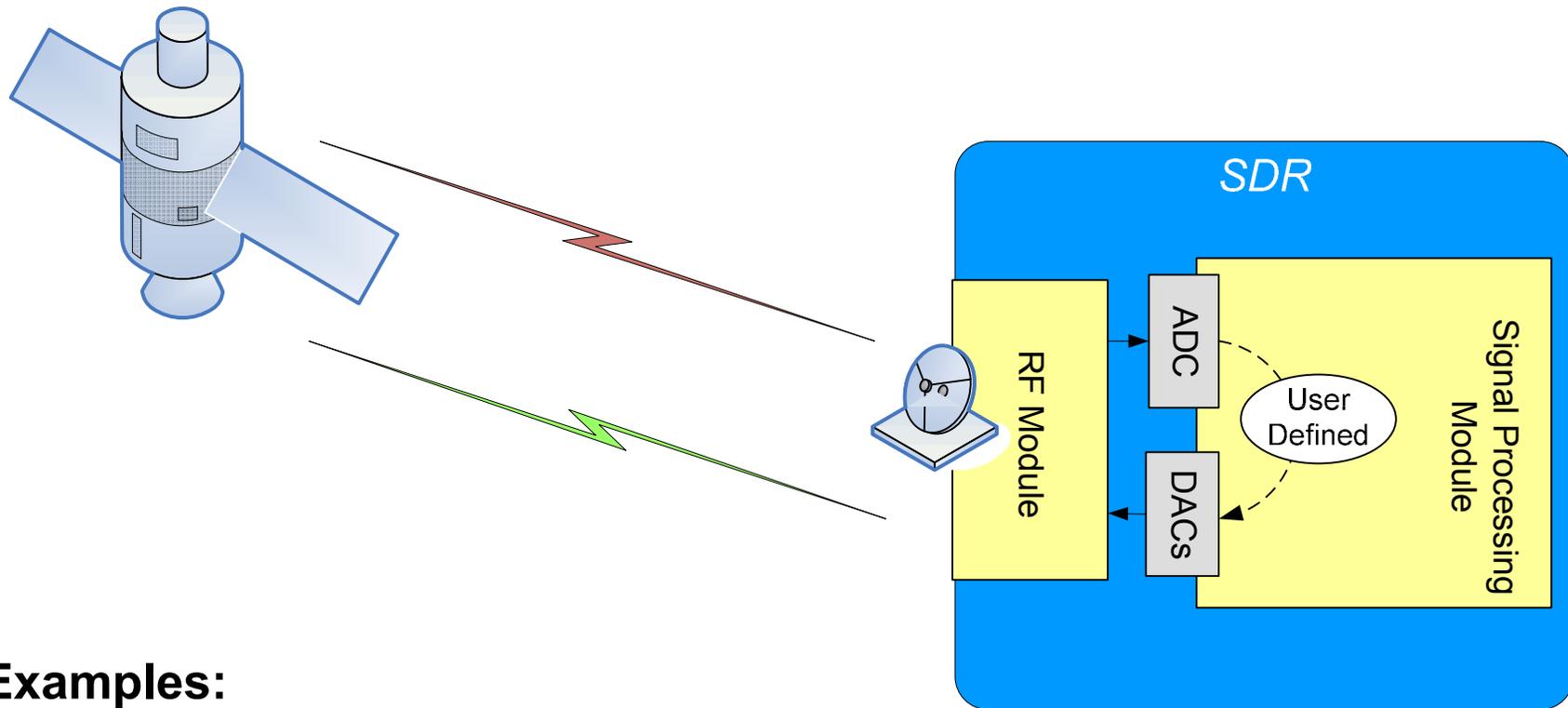
- ◆ **A test run with the waveform that returns a result or status**
- ◆ **Finite run time, and returns waveform to running or stopped state**
- ◆ **Provides special capabilities for waveform designers & operators**
- ◆ **Remains part of Waveform after deployment**

GGT Waveform Run Test 5: Temp Comp Table

```
STRS_telemetry_q: jplggt: Table Index=0 MA RFM Temperature=1137
STRS_telemetry_q: jplggt: Table Index=0 SA RFM Temperature=1087
STRS_telemetry_q: jplggt: Table Index=0 TXCO Temperature=1350
STRS_telemetry_q: jplggt:      MA I Level Delta=-1.0000E-01
STRS_telemetry_q: jplggt:      MA Q Level Delta=-1.1267E-01
...
STRS_telemetry_q: jplggt:      SA I DC Offset Delta=-2.1911E-02
STRS_telemetry_q: jplggt:      SA Q DC Offset Delta=+2.6667E-02
STRS_telemetry_q: jplggt:      MA TX Freq Delta=-3.2491E-05
STRS_telemetry_q: jplggt:      MA RX Freq Delta=-2.9919E-05
STRS_telemetry_q: jplggt:      SA TX Freq Delta=-3.1482E-05
STRS_telemetry_q: jplggt:      SA RX Freq Delta=-2.8990E-05
```



Test Waveforms On-Orbit

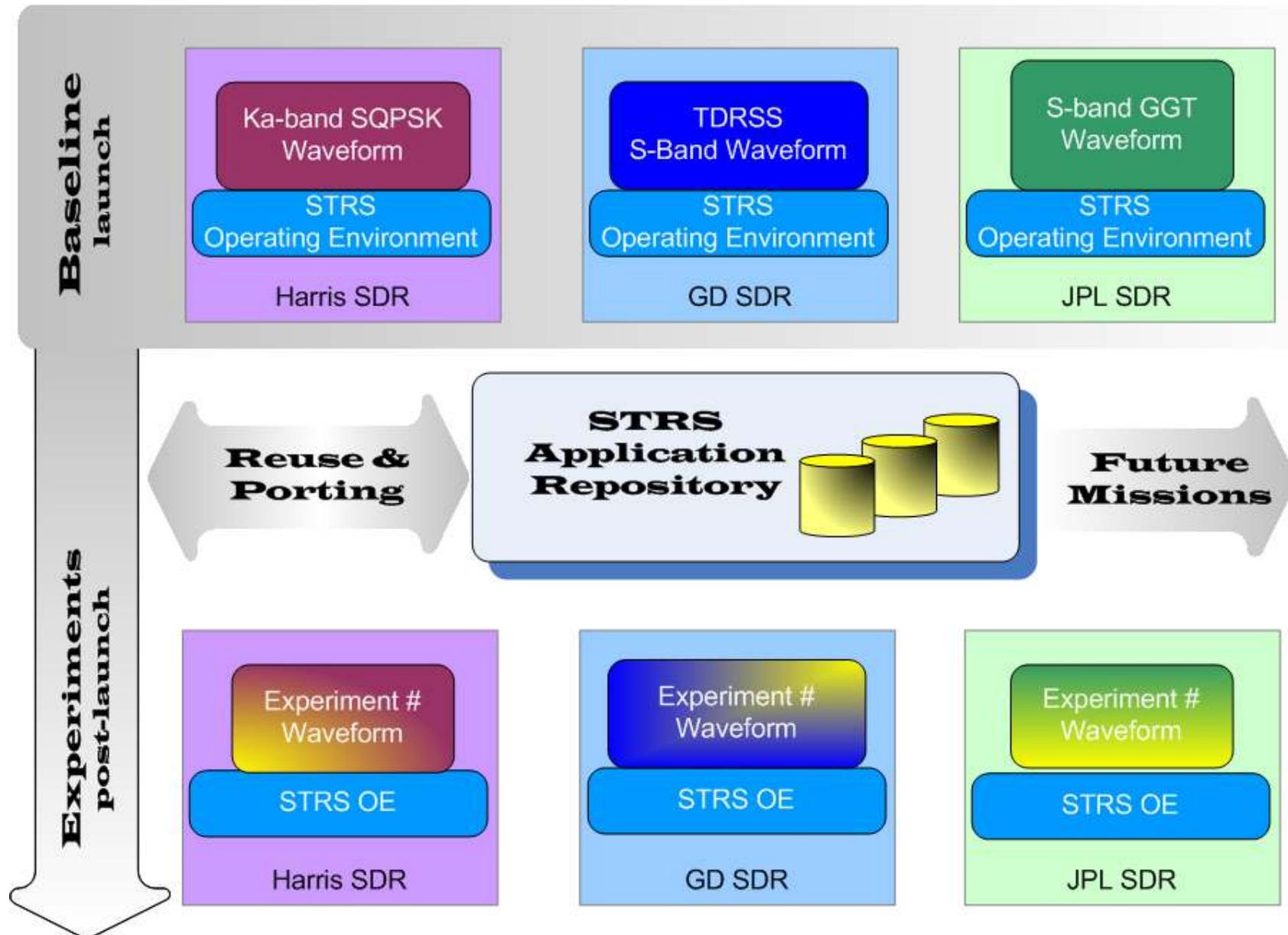


Examples:

- ◆ RF Loopback and Transponding
- ◆ FFT and raw ADC samples
- ◆ Conversion of Ground Tests to Run Tests



SDR Waveforms – STRS Repository





Experimenters Welcome



<http://spaceflight systems.grc.nasa.gov/SOPO/SCO/SCaNTestbed/>

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